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Distribution of Landslide Area in Shikoku

By Takahiko FURUYA

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Abstract

The distribution map of the landslide areas in Shikoku is shown in this paper. The author discusses on some characteristics of the relationship among landslide area distribution, geology and geomorphology, and takes his stand on the opinion that the shattered zone type landslide is an important factor in the formation of structural relief. Furthermore, the author states the shattered zone type landslides are not always due to geological structure only, and the rock properties have important influence which are subjected to fracture by tectogenesis.

1. Preface

The climate of Japan is subject to humid temperate climate and the seasonal change is clear. The large quantity of precipitation falls in spring, summer and autumn in the Pacific Seaboard of Japan, and falls in winter on the coast of the Japan Sea.

Japan belongs to the Circum-Pacific Orogenic zone, and its geological structures are complicated, and mountains occupy most of land.

There are many landslides in Japan, and they are caused by above-cited climatic and geologic conditions. Most of landslide areas in Japan are distributed in Shikoku Island and Kii Peninsula of Pacific seaboard of Japan, and in Niigata, Toyama, Yamagata, and Akita Prefectures, and the northern half of Nagano Prefecture in the coast of the Japan Sea. Moreover, some are distributed in Nagasaki and Saga Prefectures of north western Kyushu.

Koide[1] studied the landslides in Japan, and classified them into three types, (1) shattered zone type, (2) Tertiary type, (3) hot spring type. According to him, the landslide areas in Shikoku amount to hundreds, such as Morito, Choja, Tatewari, Kage, Takano, etc., and they belong to the shattered zone type. The distribution map of shattered zone type landslides is prepared in this paper from the list of landslide areas of Kagawa, Tokushima, Ehime, and Kochi Prefectures in Shikoku. Comparing with the geological maps,[2),3),4),5)] some characters of distribution of the shattered zone type landslide are explained on the basis of geological and geomorphological field surveys.

2. Outline of geology and landform in Shikoku

Shikoku is geologically divided into four zones running east to west, (1) Shikoku inner zone, (2) Sambagawa metamorphic zone, (3) Chichibu zone, (4) Shimanto-

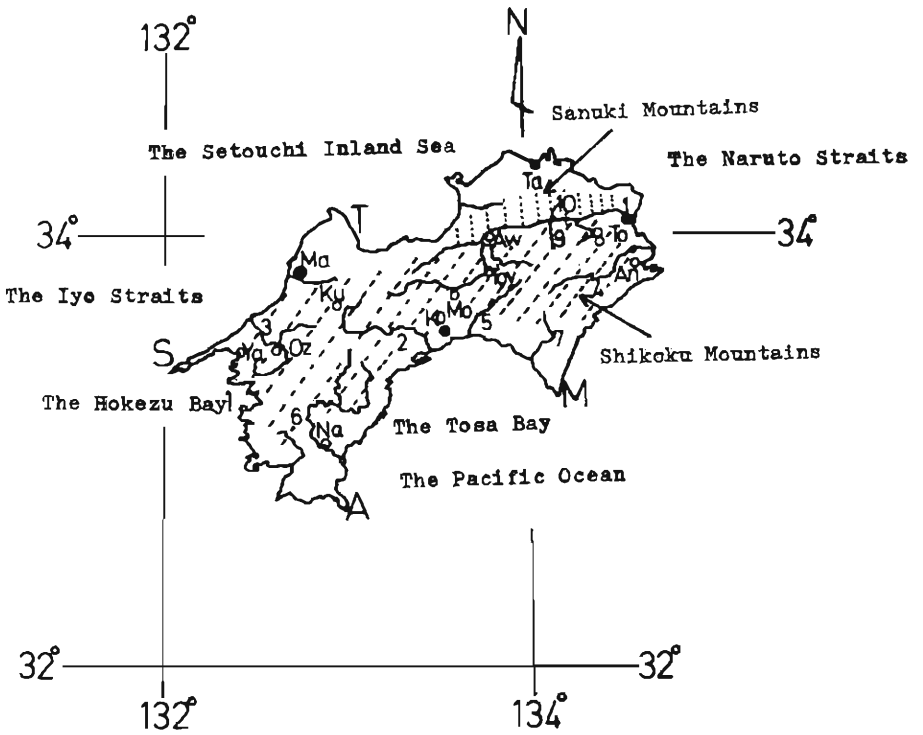

Fig. 1. Index map 1: The Yoshino River, 2: The Niyodo River, 3: The Hiji River, 4: The Naka River, 5: The Monobe River, 6: The Shimanto River, 7: The Nahari River, 8: The Anabuki River, 9: The Sadamitsu River, 10: The Nomura River, Ta: Takamatsu, To: Tokushima, Ma: Matsuyama, Ko: Kochi, An: Anan, Aw: Awa-Ikeda, Toy: Toyonaga, Mo: Motoyama, Ku: Kuma, Oz: Ozu, Ya: Yawatahama, Na: Tosanakamura, T: The takanawa Peninsula, S: The Satamisaki Peninsula, M: The Muroto Peninsula, A: The Ashizuri Peninsula

Nakamura zone. Three major structural lines, Median Dislocation Line, Mikabu line, Butsuzo-Itogawa line are the boundaries between these zones from north to south.

Median Dislocation Line reaches to Awa-Ikeda from the Straits of Naruto along the Yoshino River, then extends into the Umaji River from Awa-Ikeda, and runs through the Sakaime Pass, Iyo-Mishima, Ichinokawa, traverses through the south end of the Takanawa Peninsura, and finally, reaches into the Sea of Iyo(Fig. 2). The area to the north of the line is the Shikoku inner zone(Fig. 2).

Fault activities along Median Dislocation Line are divided into five stages at which are recognized different activities. The latest fault activity is still in action even into the Pleistocene deposits.

The Shikoku inner zone consists mainly of Ryoke granitic rocks and Mesozoic

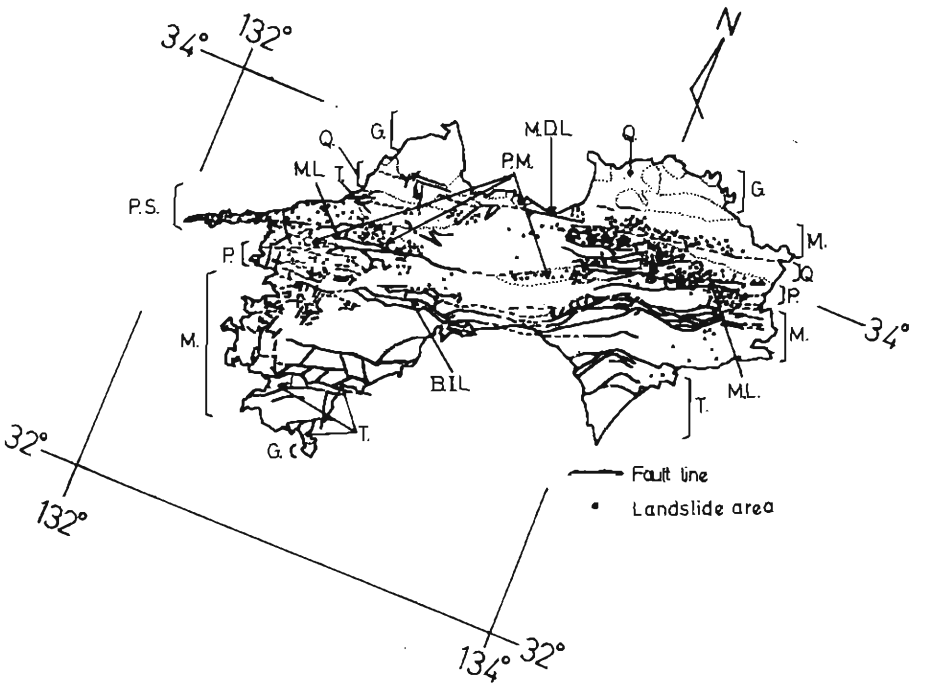

Fig. 2. Distribution of landslides in Shikoku M.D.L.: Median Dislocation Line, B.I.L.: Butsuzo-Itogawa tectonic line, P.: Palaeozoic formations, M.: Mesozoic formations, T.: Tertiary formations, Q.: Quarternary formations, P.S.: Sambagawa crystalline schists, P.M.: Mikabu green-rocks, G.: Granitic rocks.

Izumi group. Ryoke granitic rocks are widely distributed in the Takanawa Peninsula and the foreland of the Sanuki Mountains. Palaeozoic schistose hornfels appears near the Izumi group at the southern end of the Takanawa Peninsula, but is not known at the foreland of the Sanuki Mountains (Fig. 2). Mesozoic Izumi group is distributed between the Ryoke granitic rocks and Median Dislocation Line, and is mainly composed of alternated sandstone and shale, and in the Sanuki Mountains it has a bilge-shaped structure open to the east.

Mikabu line is a major structural line which starts from Komatsushima, Tokushima Prefecture, passes through the saddle between Mt. Tsurugi and Mt. Maruzasa, runs by Toyonaga on the upper stream of the Iya River and along the Minamiogawa River a tributary of the Yoshino River, then it extend along the south side of the main stream of the Yoshino, passes through Ikegawa, Kochi Prefecture and Ozu, Ehime Prefecture, and reaches to Yawatahama.

The large bodies of Mikabu green-rocks composed of metadiabase, metagabbro, etc. are distributed in Sanagochi and it's environs, Tokushima Prefecture, and in

the area between Mt. Miune and Jizoji, Kochi Prefecture to the south of the Minami-ogawa River, a tributary of the Yoshino River, and the main stream of the Yoshino.

The central Shikoku mountains between Median Dislocation Line and Mikabu line are the Sambagawa metamorphic zone which is stretched from Tokushima to the Sata promontory, and is about 30 kilometers in width in the center and about 20 kilometers at the western end of the Shikoku mountains. The zone is mainly composed of psammitic schist, pelitic schist, basic schist, and others.

Psammitic schist, so-called Oboke gneiss is largely developed around the transverse valley of the Yoshino and adjacent areas in the central Shikoku mountains.

Basic shist is distributed on large scale from the north-west Ehime Prefecture to Sata promontory. Except for above-mentioned regions, Sambagawa metamorphic zone is mainly composed of pelitic schist, or alternated layers of pelitic schist, psammitic schist, basic schist, and so forth. Palaeogene lacustrine sediments and Neogene volcanic rocks are recognized in the Kuma basin and around to the south of Matsuyama, and such sediments cover the metamorphic rocks.

Butsuzo-Itogawa tectonic line is another structural line which starts from Anan City, runs to the south of Mt. Ishitate and to the north of Mt. Koken, and reaches to the north coast of the Hokkezu Bay. Same faults are recognized within 10 kilometer of this tectonic line.

Chichibu zone between Mikabu line and Butsuzo-Itogawa line is chiefly composed of Palaeozoic formations, but Sambosan group near Butsuzo-Itogawa line, is considered to be from the upper Palaeozoic to the lower Jurasic, in which Mesozoic tectonic basins, Katsuuragawa, Monobegawa-Ryoseki, and Sakawa are recognized. The Palaeozoic formation shows remarkable alteration of rocks in the north near Mikabu line, but no alteration in the south near Butsuzo-Itogawa line. Palaeozoic and Mesozoic rocks are not so different. The formations are strongly folded and thrusted by Sakawa orogenesis.

The Shimanto-Nakamura zone is 70 kilometers in its largest width, and is composed of Mesozoic and Tertiary sedimentary rocks, with some intrusive granitic rocks recognized at Muroto, Ashizuri, and Hata Kochi Prefecture. This zone is divided into east and west by the Tosa Bay, which are connected by a narrow gallery between Akaoka and Susaki. Simanto-Makamura zone has two groups, the Shimanto group in the North and the Nakamura group in the South. The Shimanto group consists of thick formation of flysch type deposits before Sakawa orogenesis, and the Nakamura group consists of geosynclinal sediments from later Cretaceous to middle Tertiary after Sakawa orogenesis. Both group have strikes running parallel to Butsuzo-Itogawa line and remarkably repeated fold structure. The structure of Shimanto group is strikingly disturbed to the west of Kubokawa, Kochi Prefecture.

Besides the above-mentioned older formations, diluvial and alluvial deposits develop in Sanuki, Matsuyama, Tokushima, and Kochi plains.

Shikoku is mostly mountaineous, except coastal plains consisting of delta, fan, terrace, and others. Landform in Shikoku is controlled by zonal geological structures.

The Shikoku inner zone of granitic rocks and Tertiary Sediments shows chiefly hilly landforms. Volcanic neck and mesa in Sanuki plain are formed of Tertiary andsites. Sanuki mountains of Izumi group is a 800 meter high horst cut by faults in the north and south fringes. Valley development in these mountains is denser in the area of shale and mudstone, and the slopes are gentler in the east on soft rock layers and steeper in the west on hard rock layers.

The Median Dislocation Line consists of obvious fault scarps. The fault scarps face to south in Tokushima Prefecture and to north in Ehime Prefecture. There develop many fans in front of the fault scarps, and the fans are dislocated by the most recent fault activity of the Median Dislocation Line, making some eyebrow scarps.

Central Shikoku has a rectangular drainage pattern, especially, in the Sambagawa zone. The Yoshino River shows such a typical pattern. The main stream of the Yoshino has a west to east course from Motoyama to Toyonaga and a south to north course between Toyonaga and Awa-Ikeda, and a west to east course from Awa-Ikeda to Tokushima. The Iya River, a tributery of the Yoshino, has a north-south course between Deai and Ichiu, and an east to west course upper-stream from Ichiu, and the Dozan and Minamiogawa Rivers. Other tributaries of the Yoshino have east to west courses. The east to west courses have gentler valley walls and wider valley plains in contrast to north to south stream course with narror channels and steeper valley walls.

In the upper-stream of the Niyodo River, erosional basins of Kuma, Naose, Omogo, and others are cut in the Tertiary sedimentary rocks around Mt. Ishizuchi. Motoyama and Ozu basins are along the border between Mikabu green-rocks and Sambagawa metamorphic rocks. Erosion surfaces are developed around Ozu basins. Three levels of erosion surfaces are recognized at the basins of the Niyodo River. River terraces are observed only down-stream or the inland Motoyama and Kuma basins upper-stream of the Yoshino and Niyodo Rivers. The rectangular drainage pattern is not so clear in the Chichibu zone as the Sambagawa metamorphic zone.

The Shimanto-Nakamura zone is chiefly composed of highlands, which are not always gentle landforms due to the influence of crustal movements. Planation surfaces and gentle slopes are not so much developed. However, marine terraces are at the coast of Muroto and Ashizuri peninsulas, and river terraces are along the Shimanto, Monobe and other rivers, as fragmental ones. The valley in this zone are chiefly characterized as having intrenched meander and dendritic patterns, but the Monobe River controlled by tectonic lines has east to west direction in the upper-stream.

3. Distribution of landslide area

Landslide areas in Shikoku which the government appointed for prevention are shown in Fig. 2. Characters of landslide distribution are explained on the basis of the data as follows:

Landslide areas recorded in the Yoshino River drainage basin are 367, the most are found among drainage basins in Shikoku, 154, in the Hiji River drainage basin,

and 110 in the Niyodo River drainage basin. The greater part of those drainage basins belong to the Sambagawa metamorphic zone. The number of landslide area in Chichibu and Shimanto-Nakamura zones is only 14, largely in the Shimanto, Monobe and Naka River drainage basins.

Sata promontory of the Sambagawa metamorphic zone, does not have rivers, but many landslide areas are found throughout the promontory.

There is not much difference in the pattern of landslide distribution between Sanuki mountains and Shikoku Mountains in the Yoshino River drainage basin. The landslide areas of Sanuki mountains are mainly distributed in the central and western axial part. Only four landslide areas are recognized, Tanoue, Yukitsune, Itano and Inokubo, along the Median Dislocation Line of the South fringe of Sanuki Mountains. Many landslide areas are distributed along the tributaries of the Yoshino within the Sanuki Mountains. Along the Nomuradani River seven landslide areas, Joyo, Kiyoda, Irikura, Kirikubo, Okubo, Kaminakano, and Shimonakano are known, all of which are on the east-facing slope with an exception of Shimonakano landslide area (Fig. 3). Similarly, among seven landslide areas along the Ogawadani River only a part of Uchino landslide area is on the west-facing slope (Fig. 4).

Landslide areas in the Shikoku mountains of the Outer zone are more in the tributaries than the valley walls of the Yoshino River. Along the main valley of the Yoshino River the landslide areas are only 44, Naruto, Ota, Nakahoji, Shimokawa,

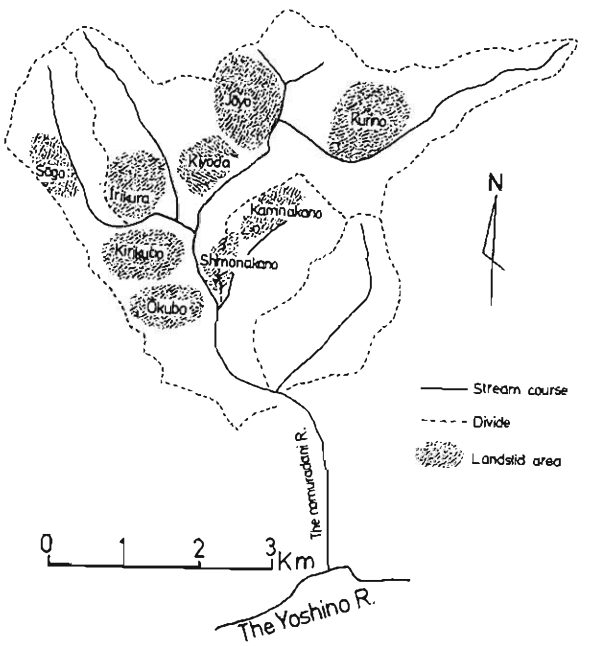

Fig. 3. Distribution of landslides and stream pattern of the Nomuradani River

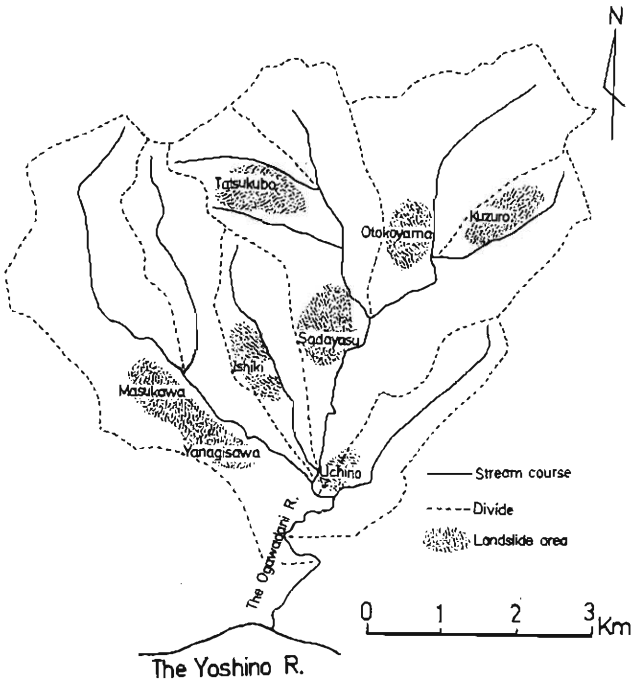

Fig. 4. Distribution of landslides and stream pattern of the Ogawadani River

Kawasaki, Suesada, Kunimasa, Sigezane, Enoki, Kakinoo, Nagabuchi, Kawado-Tsurebi, and so forth, but the landslide areas of such tributaries are 226, as the Anabuki, Sadamitsu, Dozan, Iya, and Minamiogawa Rivers, and the typical landslide areas of these tributaries are Morito, Tairadani, Zentoku, Kage, Nishikawa, and others.

The number of landslide areas does not differ with the direction of valleys, but considering the landslide areas of the tributaries, those of east to west valleys are more than those of north to south valleys. Among the landslide areas along the main valley of the Yoshino, nineteen are on the east- or west-facing slopes, and twenty five are on the south- or north-facing slopes, and there is not obvious difference of character between the landslide areas on the east- or west-facing slopes and those on the south- or north-facing slopes.

However, there are some differences with the slope directions in the tributaries. In the tributaries, the Anabuki, Sadamitsu, Dozan, Iya, and Minamiogawa Rivers, the landslide areas situated on the east- and west-facing slopes are 92, and on the south and north-facing slopes 134. For example, in the Anabuki and Iya valleys with the south to north directions, the landslide areas, Minami-Daio, Yoshinobu, Oishi, Isegawa, Nurui, Kashiyama, Tatewari, and others, are situated on the east- or west-facing slopes (Figs. 5 and 6).

The landslide areas of the Niyodo River drainage basin are distributed in the Sambagawa metamorphic zone and the Chichibu zone, and their distribution pattern

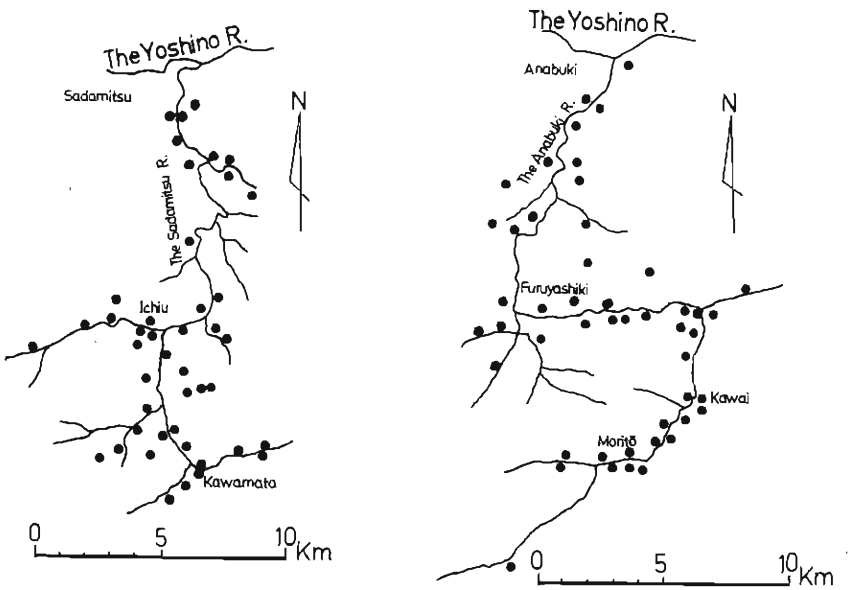

Fig. 5. Distribution of landslides and stream pattern of the Sadamitsu and Anabuki Rivers

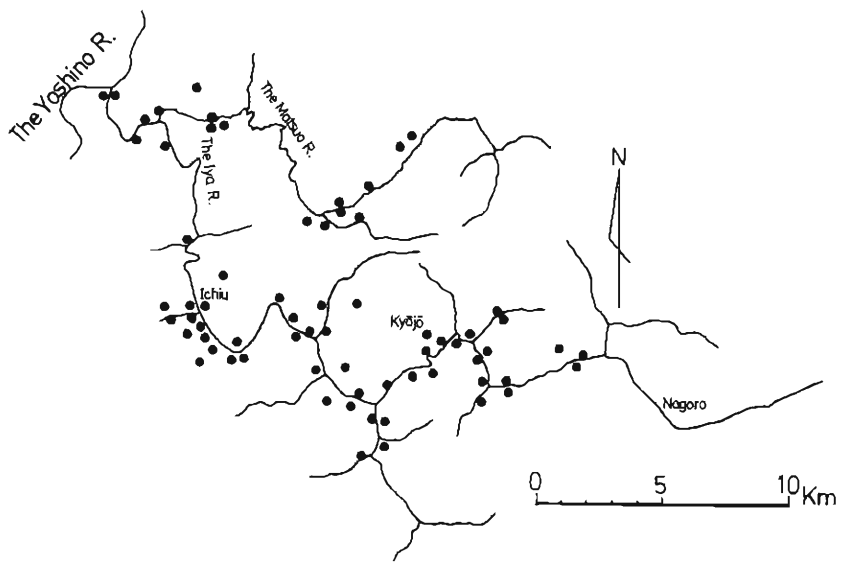

Fig. 6. Distribution of landslides and stream pattern of the Iya River

is considerably different between both zones. In the Chichibu zone, along the main stream of the Niyodo River the landslide areas are only three, Kusugami, Tokoroyama, Iwaya, and within the Choja River drainage basin, a tributary of the Niyodo, the landslide areas are five, Choja, Taketani, Oriai, and so on, and seven such as Kirimigawa, Sozu, Tsue, are scattered in other tribtaries. These landslide areas are not regularly arranged, and not fixed in the slope direction.

The Omogo and Kuma River drainage basins are mostly included in the Sambagawa metamorphic zone, but some parts of them belong to the Chichibu zone and Mikabu green-rocks. The Omogo River is the upper-stream of the Niyodo River, and the Kuma River is the first order tributary of the Niyodo River, but both rivers have almost the equal scale. The landslide areas of the Omogo River are arranged along the north to south main stream, Yanaigawa, Gassen, Naka-Kuroiwa, and others are on the exposed slope, and Hirai, Sawatari and others are on the west exposed slope. The landslide areas of Kami-Kuroiwa, Takayama, Minokawa and others are arranged along east to west courses of the Kuma and Higashi Rivers chiefly composed of pelitic schist of the Sambagawa metamorphic zone. Yokotaki is only situated on the south exposed slope of the east-west stream course in the Kuma and Higashi Rivers, and many other landslide areas such as Kami-Kuroiwa, Minokawa, are situated on the north exposed slope of the east-west stream course. The upper-stream of the Hiji River is named the Uwa River and the mid-stream of the Kano River and the Hiji River is the name of the down-stream and all river system too. This river system is the largest in Ehime Prefecture, and has the basins of Nomura, Ikazaki, and Ozu. The drainage basin is chiefly composed of the Sambagawa metamorphic zone and Chichibu zone in the western Shikoku mountains. In the Chichibu zone, the Hiji River system has a rectangular pattern constructed of the tributaries, the Oda, Nakayama, Yaochi, and Fumoto Rivers in accordance with the geological structure.

The landslide areas are mainly distributed in the drainage basins of the Nakayama, and Oda River, tributaries of the Hiji River, especially along small tributaries. The landslide areas such as Mori, Tawamaru are distributed along the main stream of the Kano River in the Chichibu zone. The distribution of landslide areas in the Hiji River drainage basin is irregular for the reasons that the stream pattern of the Hiji River does not always correspond to the geological structure and many landslide areas are along small tributaries, not big tributaries. The landslide areas of Umezu, Onji, Miyahara, Tanokubo, Nakaaze, and others, however, are arranged east to west along the Oda River in accordance with the zonal structure of the Sambagawa metamorphic zone, and are located on the north- and south-facing slopes. The landslide areas along the Kano River (the mid-stream of the Hiji River) crossing the east to west zonal structure of the Chichibu zone are located on the east- and west-facing slopes. The landslide areas of the Hiji River drainage basin are 154 in all, and among them, 143 are in the Sambagawa metamorphic zone, and only 11 are in Chichibu zone.

The Satamisaki Peninsula about 5.5 Kilometer in the largest width and about 40 Kilometer in length is mostly composed of basic schist of Sambagawa meta-

morphic zone. The landslide areas in the peninsula are amounted to 60, such as Masanodani, Handa, Yobokori, Hiraiso, Oe, Furuyashiki and others. There are more faults of the south and north direction than in the east and west direction, but the landslide areas situated on or by such faults are only five of Yobokori, Natori, Koo, and others.

There are only three landslide areas in the Shimanto and Monobe River basins mainly included in the Shimanto-Nakamura zone. But a large land-collapse is recognized in the Sakihama River drainage basin chiefly belonging to the Shimanto-Nakamura zone.

4. Relationship between landslide area distribution and geology

Some characteristics of the distribution of landslide areas are pointed out in the Yoshino, Niyodo and Hiji River drainage basins. The relationship between the distribution and the geological settings are summarized as follows (Table 1):

1). The Yoshino River Basin

The distribution of landslide area in the Yoshino River drainage basin is concentrated in two regions. One is the Sanuki mountains of the Shikoku inner zone, and the other is the central and the eastern Shikoku mountains of the Outer zone (Fig. 2).

In the Sanuki mountains are recognized only four landslide areas along the Median Dislocation Line as above-mentioned, and distributed in parallel arrangement on the horseshoe-shaped slopes open to the east in the south side of the mountain axis, and this arrangement is in accord with bilge-shaped sedimentary structure of the Izumi group which is composed of alternated sandstone and shale. The horseshoe-shaped slopes are the product of differential erosion based on the structure of sedimentary rocks of sandstone and shale, and landslides are the principal erosional agency changing those slopes.

Sediments in landslide areas are mainly talus breccia composed of angular or subangular gravels of sandstone and shale filled with loamy and clayey matrix. Uncommonly rounded and sub-rounded gravels are included, which are the detrital products based on the development of joint and bedding of sandstone and shale, and

Table 1.

Geology	Kochi Pref.		Tokushima Pref.		Ehime Pref.		Kagawa Pref.		Total	
	M.A.	N.A.	M.A.	N.A.	M.A.	N.A.	M.A.	N.A.	M.A.	N.A.
Sambagawa metamorphic rocks	62.6	(18)	47.82	(123)	14.29	(193)			29.24	(326)
Mikabu green-rocks	80.56	(27)			25.8	(2)			76.78	(29)
Palaeozoic rocks	49.94	(17)	77.97	(3)	15.58	(38)			28.88	(58)
Mesozoic rocks			70.4	(11)	5.3	(1)	35.5	(2)	60.76	(14)
Tertiary rocks					16.47	(10)	32.2	(2)	19.1	(12)
Total	66.95	(62)	50.33	(137)	15.07	(243)	33.9	(4)	33.28	(446)

* M.A.: Mean area of landslide area. N.A.: Number of landslide area.

are not immediately related to the shattered zone in the Median Dislocation Line, for the landslide areas are scarcely distributed on and by the Median Dislocation Line.

Upheaval and breaks of joint and bedding are caused by recent activity of the Median Dislocation Line, and upheaval makes the relief increase, and breaks of joint and bedding products debris in the Sanuki mountains, where the landslides are related to relief increasing and debris. The landslide areas of Shikoku mountains of Outer zone are concentrated in the well-developed psammitic schist region of the central Shikoku, the well-developed pelitic schist region of the eastern Shikoku, and the Mikabu green-rocks along the Mikabu line.

Pelitic schist region has a little crash zone by major faults, through numerous faults of a few millimeter or centimeter wide are recognized, and these faults have the east to west strike and are fitted with the main valley direction and the zonal distribution of landslide areas in the east and west direction.

The landslide areas of Mikabu green-rocks region are Kage, Mitsukono, Nuta, Nishikawa, Sagayama, along the Minamiogawa River located in the adjacent to the pelitic schist, and Yoshinobu, Oishi, Isegawa, Tatewari, Matsukino, around Motoyama along the Mikabu line. Mikabu green-rocks are hard and blocky in field view generally, and have a large number of fissures above ten centimeter in length and one meter in width on outcrop which are mostly fault fracture or joint caused by the Mikabu line, and schistosity. Their properties are related to detrital materials of landslide areas, especially, the phyllitic rocks are mostly related to detritus.

The landslide areas of psammitic schist region are small in number as compared with pelitic schist and Mikabu green-rocks regions, and only seven, Tairashimo, Nishiu, Nishiumine, Tsuya, Tsuya-shimo, Maruta, Mizunashi. However, many rock falls happen on the steep valley walls of transverse valleys of the Yoshino River.

The bedding, schistosity, fissility and exfoliation are developed in psammitic schist metamorphosed from fine-grained sandstone, and such properties weaken the psammitic schist metamorphosed from medium and coarse sandstone, but schistosity and bedding in psammitic schist are not so well developed as in pelitic schist. However, joints are general in psammitic schist, which are frequently ruptured, and there remains blocks of psammitic schist. The rock falls seem to be caused by fissility, exfoliation and blocks.

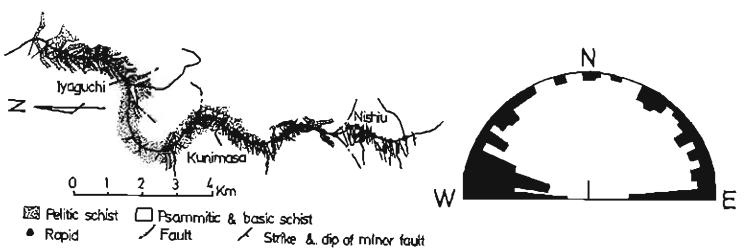

Fig. 7. Geological route map and frequency pattern of strike of minor faults

Remarkably many landslide areas in the pelitic schist region are on the east-west valley walls. In the pelitic schist, schistosity, bedding, and fracture cleavage are developed remarkably, and fissility and exfoliation are exceedingly abundant, and schistosity plaines, cleavage faces and minor faults are approximately in the east and west direction (Fig. 7).

The landslide areas in the Mikabu green-rocks region have wide paddy field and the landslide areas in pelitic schist and Izumi group region are utilized for upland fields. Expansible clay is detected in the landslide areas in the Mikabu green-rocks region.

2). *The Niyodo River Basin*

The Sambagawa metamorphic zone in the Niyodo River basin is mostly composed of basic schist, not found in the eastern Shikoku as mentioned above. The Chichibu zone is mainly composed of sedimentary rocks of sandstone, phyllite, chert, and others. The landslide areas of both zones have detrital materials of angular and subangular breccias with loamy matrix, which are derived from basic schist, phyllite, and Mikabu green-rocks. Particular differences are not recognized in the distribution pattern of landslide area between the Sambagawa metamorphic zone and the Chichibu zone. The landslides areas in the Sambagawa metamorphic zone have a tendency to be arranged in the east and west direction, and the Kuma and Higashi Rivers give good examples. However, such a tendency is not recognized in the Chichibu zone at all.

Main faults in the Niyodo River drainage basin are the Mikabu line and the Butsuzo-Itogawa tectonic line, but the concentrated distribution of the landslide areas is not obvious along these fault lines. In this drainage basin principal structures such as strike, liniation, fracture cleavage face, schistosity plane are in the east and west direction, and the landslides are mainly based on the properties of schistosity, joint, fracture cleavage and others in the basic schist and pelitic schist of the Sambagawa metamorphic zone. The properties of landslides in Tertiary region included within the Sambagawa metamorphic zone are due to lutaceous rocks, but yet there is not enough data for the evidence.

The landslide areas are not linearly distributed in the Chichibu zone, and the relation between landslide areas and the Butsuzo-Itogawa tectonic line is not clear. There are remarkably fractured green-rocks at Sozu and Tokoroyama landslide areas, and the rocks may be related to the Mikabu green-rocks. The Choja landslide area is composed of base rock of surpentine and phyllite, and Taketani landslide area is mainly composed of phyllite. Accordingly, it seems that the landslide areas of the Chichibu zone are related to the properties of joint and fissility from phyllite and green-rocks.

3). *The Hiji River Basin*

The northern Hiji River drainage basin consists of basic schist in the north, and pelitic schist in the south of the Sambagawa metamorphic zone, but distribution of landslide areas shows no difference between the north and south. The Oda River stream

course in the east and west direction is composed of pelitic schist, and the landslide areas are arranged along this stream course. Fold structure of the east and west direction is well-developed in the basic schist region, but the east and west arrangement of landslide areas is not so remarkable in the basic schist region as in the pelitic schist region.

The southern Hiji River drainage basin is included in the Chichibu zone, mainly composed of phyllite in the north, and schalstain in the south. The landslide areas are less than in the Sambagawa metamorphic zone, and distributed on and around the principal fault line.

4). *The Satamisaki Peninsula*

The distribution of landslide areas is not related to fault structure, and is related to the rock texture and chemical composition of basic schist.

5. Conclusion

The results of this study on the distribution of the landslide areas in Shikoku are summarized as follows:

1). The landslide areas are distributed largely in the Sambagawa metamorphic zone and in the Mesozoic Izumi group, and less in the Chichibu zone and in the Shimanto-Nakamura zone.

2). Shattered zone type landslides in Shikoku occur on the basement rocks such as alternated sandstone and shale, pelitic schist, basic schist, Mikabu green-rocks, phyllite, and are strongly affected by rock property, rock texture and minor fault zones of a large fault line.

3). The deposits of landslide areas mainly consist of angular and subangular gravels or blocks with some small quantity of clay, and on rare occasions, subrounded gravels.

4). The distribution of shattered zone type landslide area is closely related with the drainage pattern and valley slope form.

5). The landslide is an important factor in the formation of structural relief.

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